REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From – To)*
3 May 2013	Consultative Letter	May 2012 – Feb 2013

4. TITLE AND SUBTITLE

Acoustical Assessment of Firing Range, Osan AB, South Korea

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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8. PERFORMING ORGANIZATION REPORT NUMBER

AFRL-SA-WP-CL-2013-0007

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW-2013-2086, 3 May 2013

13. SUPPLEMENTARY NOTES

14. ABSTRACT

An acoustical assessment was performed on the Combat Arms Firing Range at Osan AB in May 2012. It was determined that the noise in the firing range did not meet the definition of impulse noise in AFOSH Standard 48-20 due to acoustical reflections, particularly off the side walls. Therefore, it was recommended that acoustical absorption be added to these side walls to reduce the reverberant field.

15. SUBJECT TERMS

Impulse noise, impact noise, time delay, CATM, firing range, hearing, acoustics, noise, firearms

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Mr. Andrew T. Wells
U	U	U	SAR	8	19b. TELEPHONE NUMBER *(include area code)*

DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

3 May 2013

MEMORANDUM FOR 51 AMDS/SGPB
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UNIT 2060
APO AP 96278

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433-7913

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0007, Acoustical Assessment of Firing Range, Osan AB, South Korea

1. INTRODUCTION:

a. On 21-25 May 2012, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC) and USAFSAM Detachment 3 (DET 3-USAFSAM/CD), at the request of 51 AMDS/SGPB, performed an acoustical assessment of the Combat Arms Training and Maintenance (CATM) firing range facilities at Osan AB, South Korea. Upon completion of the assessment, the noise at the CATM range was classified as continuous as opposed to impulse noise. The purpose of this letter is to show the significance of this continuous noise classification as it pertains to noncompliance with AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program.* The need for acoustical treatment is required to alter the noise classification from continuous to impulse noise.

b. *Survey Personnel*:

(1) Chief, Occupational Health Services, DET 3-USAFSAM/CD
(2) Flight Chief, Consultation Division, DET 3-USAFSAM/CD
(3) Consultant, Industrial Hygiene Technician, USAFSAM/OECM
(4) Senior Noise Engineer, USAFSAM/OECC

c. *Personnel Contacted*:

(1) Bioenvironmental Technician, 51 AMDS/SGPB
(2) Bioenvironmental Technician, 51 AMDS/SGPB
(3) Combat Arms Training Instructor, 51 SFS/S4C

d. *Equipment*:

(1) B&K PULSE Analyzer, Type 3560-B-140, SN 2588445
(2) Larson Davis Microphone Power Supply, Model # 2221, SN 0207
(3) Larson Davis Preamplifier, Model # 902, SN 3824
(4) Larson Davis Microphone, Model # 2530, SN 1483
(5) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. The Osan AB CATM range is a fully contained range with 12 total firing stations. The range has two separate sides: lanes 1-6 (see Figure 1) on the left and 7-12 (see Figure 2) on the right. There is a wall dividing the sides, and the control tower (see Figure 3) at the back oversees both sides. A noise-reverberant field occurs during firing, where the noise energy is reflected off the ceiling, walls, and floor surfaces, thereby increasing noise levels for a longer duration. These noise levels diminish slowly compared to noise levels in free field conditions (i.e., outdoors or indoors with acoustical absorption on the interior surfaces). Down range of the firing line is a series of steel safety baffles on the ceiling that are designed to deflect stray bullets and prevent the bullets from leaving the range. These panels are closely spaced and reflect acoustical energy, contributing to the increased duration of noise levels.

Figure 1. Osan CATM Range Lanes 1-6, Left Side

Figure 2. Osan CATM Range Lanes 7-12, Right Side

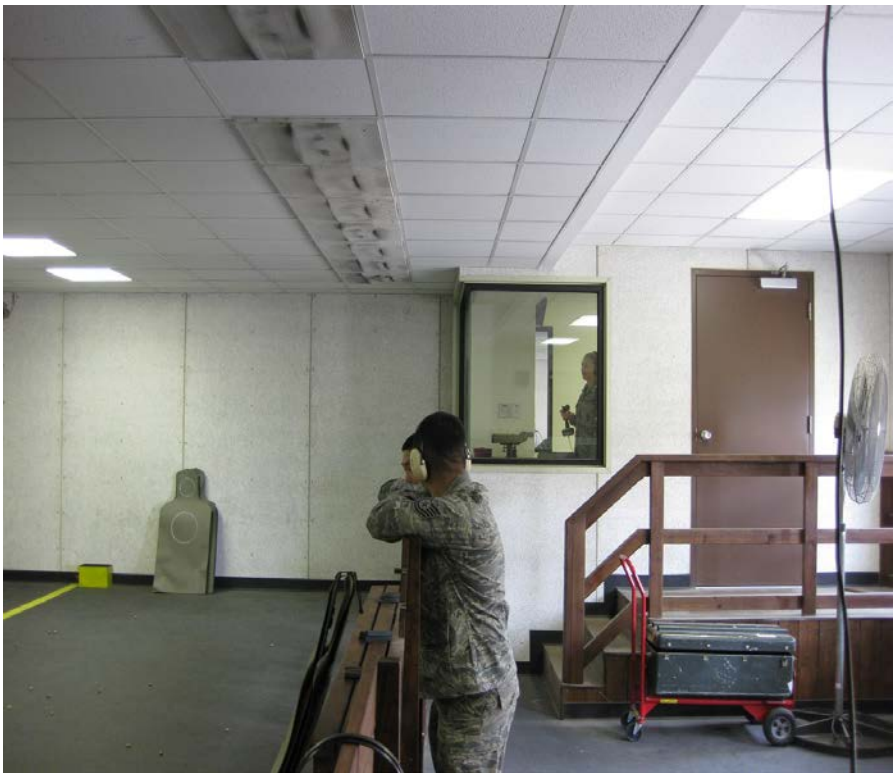

Figure 3. Osan CATM Range Control Tower

b. The nonlinear acoustical effects of the gunfire peak noise, double hearing protection, and short-term residual auditory effects from gunfire make it very difficult for students and instructors to communicate. Communication difficulties include understanding instructions and warning signals. To compensate for the multiple noise sources, the volume of the control tower speaker system is fixed at a high level. When hearing protection is not worn (i.e., providing/receiving group instruction), the students are exposed to high levels of noise from the speakers.

c. The maximum level of **continuous noise** that is allowed to reach the ear shall not exceed 115 dBA, and the maximum level of **impulse noise** that is allowed to reach the ear shall not exceed 140 dB peak SPL, in accordance with AFOSH Standard 48-20.

3. METHODS:

a. The SPL time histories corresponding to individual M4 and M9 weapon shots were measured with ¼-inch microphones placed 5 feet above the yellow line (the safety line behind which students remain when not shooting); see Figure 4 for microphone positions. Time histories are measured SPLs over a duration of approximately 4 seconds. This duration provided sufficient time to completely describe the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

b. On the first day of the assessment, SPL time history data were collected while three base personnel each fired an M9 on the left side of the range, lanes 1-6. On the second day of the assessment, data were collected while three personnel each fired an M4 on the right side of the range, lanes 7-12. Assessment data were also collected while three personnel each fired an M4 on the left side, and the microphone was moved inside the control tower of the CATM range.

c. The linear SPL decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. The slope of this curve is the decay rate.

d. Decay times, in seconds, were computed based on the decay rate by calculating the duration of time required for the SPL to decay from 150 dB down to 80 dB, due to the fact that noise decay above 150 dB is nonlinear.

4. RESULTS:

a. The noise decay at the Osan AB CATM range **does not** meet the definition of impulse noise in accordance with AFOSH Standard 48-20. The definition states that impulse noise is **"**a short burst of acoustic energy consisting of either a single burst or a series of bursts. The pressure-time history of a single burst includes a rapid rise to a peak pressure followed by a somewhat lower decay of the pressure envelope to ambient pressure, both occurring **within 1.0 second**. A series of impulses may last longer than 1.0 second."

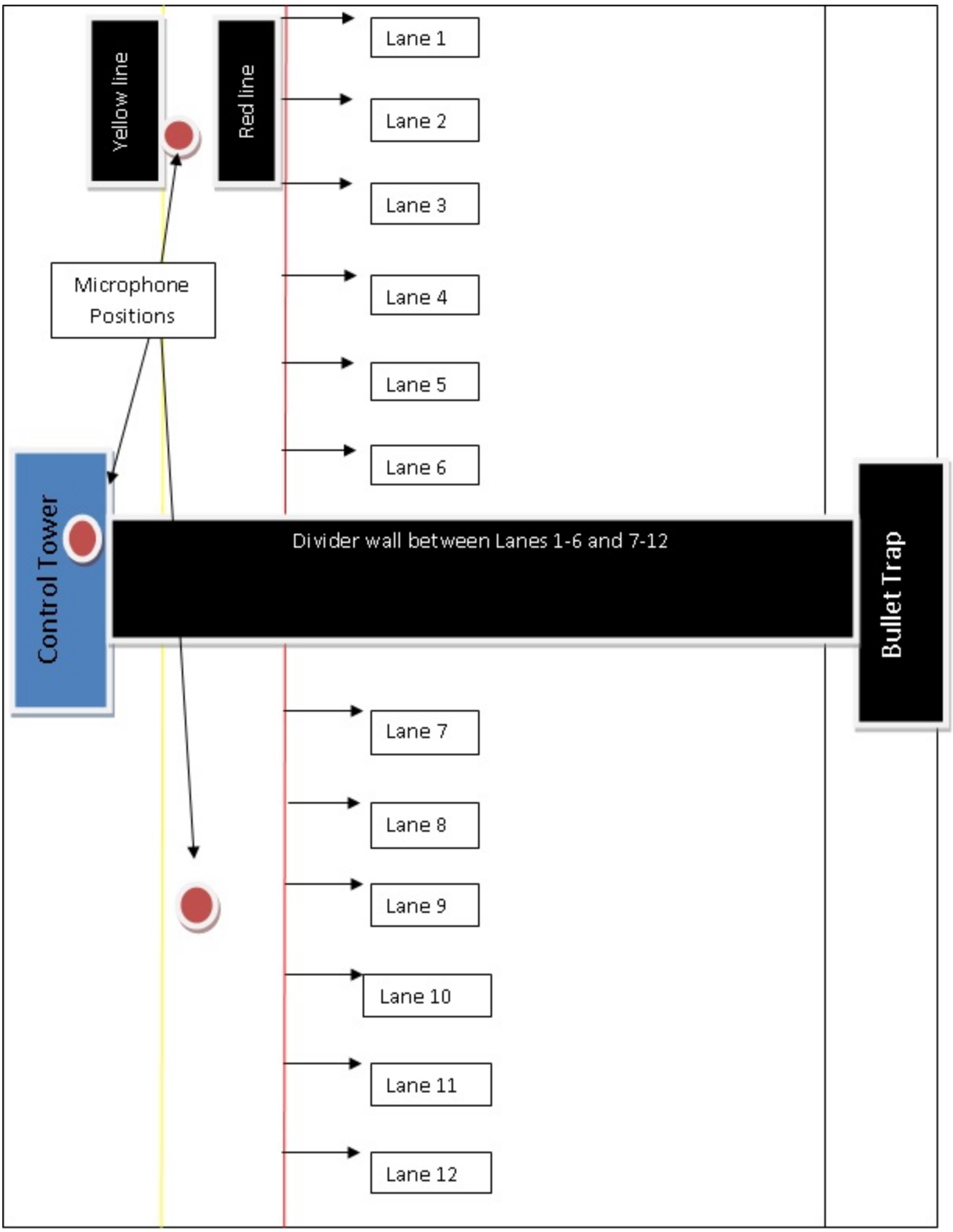

Figure 4. CATM Range Layout and Microphone Positions

b. The decay time, when averaged over multiple shots and two different types of weapons, was **1.5 - 1.7 seconds**. See Table 1 for a summary of noise characterization and decay times.

Table 1: Noise Characterization by Decay Time

Weapon System/Area	Noise Level* (dB)	Average Decay Time (s)	Noise Characterization	Maximum *Continuous* Noise Level (dB)	Exceeds Continuous Noise Std. (Yes/No)
M4	123	1.7	***Continuous***	115	**YES**
M9	123	1.5	***Continuous***	115	**YES**
Inside the Tower(M4)	123	1.7	***Continuous***	115	**YES**

* Noise level with double hearing protection providing 33 dB of attenuation.

5. CONCLUSIONS:

a. Based on the average decay times in each area, the noise in the range is not impulse noise; the noise is continuous noise. Thus, the hazardous noise does not meet the regulatory definition of impulse noise. Based on the continuous noise standard, there is no allowed exposure time above 115 dBA.

b. Speech intelligibility is poor due to the strong reverberant sound field of the range. This condition increases safety risks.

6. RECOMMENDATIONS:

a. Until effective engineering controls can be implemented, consider close scrutiny to audiograms, as defined in Attachment 1 of AFOSH Standard 48-20, for CATM instructors, as they **are not** adequately protected in the current range configuration with personal protective equipment and administrative controls.

b. **Install sound-absorbing material to reduce the reverberant field.** The reverberant field in each range should be minimized to reduce the noise level to protect instructors and students from hazardous noise exposure and to improve speech intelligibility.

c. For each firing area, treat the first overhead baffle, as well as the ceiling and walls from the red line back, to include the rear walls, with acoustical absorption material. Quilted fiberglass, or other fiberglass panels wrapped in a manor allowing easy cleaning, is one option. There are also more fixed installation materials available, such as products offered by Pyrok or Troy Acoustics.

d. The CATM control tower would benefit from the same treatment as the firing ranges. Install the materials on the left and right walls, the ceiling, and the back wall. The peak SPLs observed in the tower were 120 dB or less; therefore, follow-up noise dosimetry is recommended to be accomplished in the control tower only.

e. **Adjust the speaker system volume for weapons discharge or instructor lecturing. Additionally, ensure CATM instructors provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction.** NIOSH has a short video on proper insertion of foam ear plugs available for download at: http://www.cdc.gov/niosh/mining/products/movies/rphhi.wmv.

f. **Perform a follow-up assessment after acoustical treatment of the range is complete.** The assessment would determine overall effectiveness and evaluate the type of noise—impulse noise versus continuous noise.

7. If you have any further questions regarding this report, please contact Mr. Andrew Wells at DSN 798-3306 or andrew.wells@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Lt Col Sonntag at DSN 798-3328 or david.sonntag@us.af.mil. To improve our services, please complete and return the critique provided with this report.

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